

APPENDIX A

DEFINITIONS

Abnormal Operation ("Upset") is a situation in which emission rates change because of unusual occurrences that affect normal plant operating conditions.

Absorbed Dose (D) is the energy imparted to matter by ionizing radiation per unit mass of irradiated material at the place of interest in that material. The absorbed dose is expressed in units of rad (gray) where 1 rad = 0.01 joule/kg material (1 gray = 100 rad).

Acceptance Sampling is the procedure by which decisions to accept or reject a sampled lot or population are made based on the results of a sample inspection.

Accuracy is the degree of agreement of a measurement with an accepted reference or true value. It is expressed as the difference between the two values, as the difference as a percentage of the reference or true value, or as a ratio of the measured value and the reference or true value.

ALARA (As Low As Reasonably Achievable) is a phrase (acronym) used to describe an approach to radiation protection to control or manage exposures (both individual and collective to the workforce and the general public) and releases of radioactive material to the environment as low as social, technical, economic, practical, and public policy considerations will permit. As used in this guide, ALARA is not a dose limit, but rather it is a process that has as its objective the attainment of dose levels as far below applicable limits as is practicable.

Aliquot is the fraction of a field sample taken for complete processing through an analytical procedure (a "laboratory sample" of a field sample).

Analytical Blank - See "Blank."

Analytical Detection Limit - See "Lower Limit of Detection (LLD)."

Analytical Limit of Discrimination is a concentration above which one can, with relative certainty, ascribe the results from an analysis to concentrations that exist in the environment or system being evaluated.

Aquatic Biota is plant or animal life living in, near, or on water, or having water as a habitat.

Arithmetic Mean is the most commonly used measure of central tendency, commonly called the "average." Mathematically, it is the sum of all the values of a set divided by the number of values in the set:

$$\bar{X} = \frac{\sum_{i=1}^n X_i}{n}$$

Audit/Appraisal is a planned and documented activity performed in accordance with procedures to determine, by examination and evaluation of objective evidence, the adequacy of and extent to which applicable elements of the program have been developed, documented, and effectively implemented in accordance with specified requirements. Audits can be either internal examinations of programs or activities under an organization's control and within its organizational structure or external examinations of programs or activities of another organization.

Average - See "Arithmetic Mean."

Best Available Technology (BAT) means the preferred technology for treating a particular process liquid waste, selected from among others after taking into account factors related to technology, economics, public policy, and other parameters. BAT is not a specific level of treatment but the conclusion of a selection process that includes several treatment alternatives.

Bias is a consistent under- or over-estimation of the true values representing a population.

Blank is a sample of the carrying agent (gas, liquid, or solid) normally used to selectively measure a material of interest that is subjected to the usual analytical procedures process to establish a baseline or background value. This value is then used to adjust or correct the routine analytical results.

Calibration is the adjustment of the system and the determination of system accuracy using known sources and instrument measurements. Adjustment of flow, temperature, humidity, or pressure gauges and the determination of system accuracy must be conducted using standard operating procedures and "Standard Reference Materials" (SRM) that are traceable to the National Institute of Standards and Technology (NIST) or other "Certified Reference Materials" (CRM).

Calibration Standard is a standard used to quantify the relationship between the output of a sensor and a property to be measured. Calibration standards must be traceable to "Standard Reference Materials" (SRM) from NIST or Certified Reference Materials (CRM).

Check Source is a source (e.g., a radioactive source) not necessarily calibrated that is used to confirm the continuing satisfactory operation of an instrument (also termed "Reference Source").

Coefficient of Variation [CV; or Relative Standard Deviation (RSD)] is a measure of precision calculated as the standard deviation value (s for a sample or σ for a population) divided by the average of a set of values (\bar{X} for a sample or μ for a population). It is usually multiplied by 100 to be expressed as a percentage.

$$CV = RSD = \frac{s}{\bar{X}} \times 100 \text{ for a sample, or}$$

$$CV' = RSD' = \frac{\sigma}{\mu} \times 100 \text{ for a population.}$$

Collective Dose Equivalent is the sum of the dose equivalents of all individuals in a specified population, frequently considered to be that within 50 mi of the facility or release point. It is expressed in units of person-rem or person-sieverts (1 person-Sv = 100 person-rem).

Collective Effective Dose Equivalent is the sum of the effective dose equivalents of all individuals in a specified population, frequently considered to be that within 50 mi of the facility or release point. It is expressed in units of person-rem or person-sieverts (1 person-Sv = 100 person-rem).

Collectors (Control Equipment) are devices designed to remove and collect contaminants from an effluent stream.

Committed Dose Equivalent (H_{50}) is the predicted total dose equivalent to a tissue or organ over a 50-year period after a known intake of a radionuclide into the body. It does not include contributions from external dose. Committed dose equivalent is expressed in units of rem (or sievert).

Committed Effective Dose Equivalent ($H_{E, 50}$) is the sum of the committed dose equivalents to various tissues in the body, each multiplied by the appropriate weighting factor. Committed effective dose equivalent is expressed in terms of rem (or sievert).

Confidence Coefficient is the chance or probability, usually expressed as a percentage, that a confidence interval includes some defined parameter of a population. The confidence coefficients usually associated with confidence intervals are 90%, 95%, and 99%. For a given sample size, the width of the confidence interval increases as the confidence coefficient increases.

Confidence Interval is a value interval that has a designated probability (the confidence coefficient) of including some defined parameter of the population.

Confidence Limits are the outer boundaries of a confidence interval.

Continuous Monitoring is the real-time measurement of liquid, gaseous, and/or airborne effluents and contaminants using in situ measurement systems.

Continuous Sampling includes both noninterrupted sampling and repetitive sequential collection of small samples obtained automatically at intervals short enough to yield a representative sample for the entire sampling period.

Control Chart is a graphic chart with statistical control limits and plotted values (usually in chronological order) of some measured parameter for a series of samples. Use of the charts provides a visual display of the pattern of the data, enabling early detection of time trends and shifts in level.

Corroborative Tests are the evaluation of an analytical method in which a number of laboratories analyze portions of carefully prepared homogeneous samples.

Critical Organ is the human organ or tissue receiving the largest fraction of a specified dose limit.

Critical Pathway is the specific route of transfer of radionuclides from one environmental component to another (e.g., from one trophic level to another) that results in the greatest fraction of an applicable dose limit to a population group or an individual's whole body, organ, or tissue.

Critical Population Group is the population group showing the greatest fraction of an applicable radiation dose limit as a result of site releases.

Data Validation is a systematic review of a data set to identify outliers or suspect values. The process uses appropriate statistical techniques to screen out impossible or highly unlikely values.

Deep Dose Equivalent, as used in this guide, means the dose equivalent in tissue at a depth of 1 cm or greater, selected to maximize the dose equivalent derived from external (penetrating) radiation.

Derived Concentration Guide (DCG) is the concentration of a radionuclide in air or water that, under conditions of continuous exposure by one exposure mode (i.e., ingestion of water, or submersion in air, or inhalation), for one year would result in an effective dose equivalent of 100 mrem (1 mSv) to a "reference man."

Detector is a device for converting radiation flux and energy to a signal suitable for measurement purposes.

Diffuse Source is a source or sources of radioactive contaminants (emissions) released into the atmosphere that do not have a defined point (origin) of release (i.e., a non-point source). Such sources are also known as area sources.

Discharge Point is any discernible, confined, and discrete conveyance, including but not limited to any stack, duct, vent, pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, or vessel from which any radioactively contaminated gas or water is discharged to the atmosphere or waters accessible by the general public.

Dose Equivalent (D_E) is the product of the absorbed dose in rads (grays) in tissue, a quality factor, and other modifying factors. Dose equivalent is expressed in units of rem (or sievert). (1 rem = 0.01 sievert.) For purposes of this guide, the dose equivalent to an organ, tissue, or whole body in a year will be that received from the direct exposure plus the 50-year committed dose equivalent received from radionuclides taken into the body during the year.

Effective Dose Equivalent (H_E or EDE) is the summation of the products of the dose equivalent received by specified tissues of the body and a tissue-specific weighting factor. This sum is a risk-equivalent value and can be used to estimate the health-effects risk of the exposed individual. The tissue-specific weighting factor represents the fraction of the total health risk resulting from uniform whole-body irradiation that would be contributed by that particular tissue. The effective dose equivalent includes the committed effective dose equivalent from internal deposition of radionuclides and the effective dose equivalent due to penetrating radiation from sources external to the body; it is expressed in units of rem (or sievert).

Effluent is any treated or untreated air emission or liquid discharge, including stormwater runoff, at a DOE site or facility.

Effluent Monitoring is the collection and analysis of samples or measurements of liquid, gaseous, or airborne effluents for the purpose of characterizing and quantifying contaminants and process stream characteristics, assessing radiation exposures to members of the public, and demonstrating compliance with applicable standards.

Emission - See "Effluent."

Environmental Detection Limit is the smallest level at which a radionuclide in an environmental medium can be unambiguously distinguished for a given confidence level using a particular combination of sampling and measurement procedures, sample volume, analytical detection limit, and processing procedure.

Environmental Medium is a discrete portion of the total environment, animate or inanimate, that may be sampled or measured directly.

Environmental Surveillance is the collection and analysis of samples of air, water, soil, foodstuffs, biota, and other media from DOE sites and their environs and the measurement of external radiation for purposes of demonstrating compliance with applicable standards, assessing radiation exposures to members of the public, and assessing effects, if any, on the local environment.

Environs are the environment surrounding a facility or site.

Error is the difference between an observed or measured value and its true value.

Facility, as used by DOE, refers to a building, structure, or group of buildings and/or structures that releases radionuclides and is subject to the regulations/standards pertinent to this guide. When considering 40 CFR Part 61-related subjects for reporting to EPA, the term "facility" is to be considered the same as the DOE term "site," and the term "source" is to be considered the same as the DOE term "facility."

Geometric Mean is mathematically expressed as the n^{th} root of the product of all values in a set of n values:

$$1) \quad \bar{X}_g = \left[\prod_{i=1}^n X_i \right]^{1/n}$$

or as the antilogarithm of the arithmetic mean of the logarithms of all the values of a set of n values:

$$2) \quad \bar{X}_g = \text{antilog} \left[\frac{\sum_{i=1}^n \log X_i}{n} \right]$$

The geometric mean is generally used when the logarithms of a set of values are normally distributed, as is the case for much of the monitoring and surveillance data.

Geometric Standard Deviation is mathematically expressed as the antilog of the standard deviation of the logarithms of the measurements:

$$S_g = \text{antilog} \left[\sum_{i=1}^n \left[\frac{\log X_i - \frac{\sum_{i=1}^n \log X_i}{n}}{n-1} \right]^2 \right]^{1/2}$$

Grab Sample is a single sample acquired from an effluent stream over a short interval of time.

Impaction is a process by which a particle or droplet is removed from an airstream by striking a surface in contact with the airstream. When a particle grazes a surface and is thus retained, the term "interception" applies.

In-line refers to a system in which a detector or other measuring device is placed in the effluent stream for purposes of performing measurements on the effluent stream.

Isokinetic describes a condition that prevails when the velocity of air entering a sampling probe held in the airstream is identical to the velocity and axis of flow of the airstream being sampled at that point.

Less Than Detectable (LTD) refers to a measurement or calculated concentration that is not statistically different from the associated background or control value at a preselected confidence level.

Lower Limit of Detection (LLD) is the smallest amount of a contaminant that can be distinguished in a sample by a given measurement procedure at a given confidence level. [Also called "Minimum Detection Level" (MDL).]

Management and Operating (M&O) Contract means an agreement under which DOE contracts for the operation, maintenance, or support, on its behalf, of a Federally owned or controlled research, development, special-production, or testing establishment wholly or principally devoted to one or more major programs of DOE (source: 48 CFR 17.601). M&O contracts are designated as such only by the Secretary or Under Secretary, in accordance with 48 CFR 17.602.

Measurement is the quantification of a parameter, a contaminant, or gross content of material associated with a liquid or airborne effluent stream.

Measures of Central Tendency are measures of the tendency of values within a set of data to be centered at some location (e.g., median, mode, arithmetic mean, and geometric mean).

Measures of Dispersion or Variability are measures of the differences, scatter, or variability of values within a set of numbers. Commonly used measures of dispersion or variability are the range, standard deviation, variance, and coefficient of variation.

Median is the middle value of a set of data when the data are ranked in increasing or decreasing order. If there are an even number of values in the set, the median is the arithmetic average of the two middle values; if the number of values is odd, it is the middle value.

Membrane Filter is one of several commercially available filter media consisting generally of very thin organic-based films having a range of selectable porosities and controlled composition. Very thin, porous metallic filters are also known as membrane filters.

Minimum Detection Level (MDL) - See "Lower Limit of Detection (LLD)."

Mode refers to the value occurring most frequently in a data set.

Monitor has two definitions: 1) To measure certain constituents or parameters in an effluent stream continuously or at a frequency that permits a representative estimate of the amount over a specified interval of time; and 2) the instrumentation or device used in monitoring.

Monitoring is the use of instruments, systems, or special techniques to measure liquid, gaseous, and/or airborne effluents and contaminants.

Off-Line Monitoring Systems are systems in which an aliquot is withdrawn from the effluent stream for collection or conveyance to a detector or assembly.

Onsite refers to the area within the boundaries of a facility or site that is or can be controlled with respect to access by the general public.

Outlier is an extreme value in a data set so far removed from the other values with which it is associated that the chance probability of its being a valid member of the group is very small. Such a questionable value may be eliminated from the group on the basis of further statistical investigations of the data set.

Particle is an aggregate of molecules forming a solid or liquid that ranges in size from a few molecular diameters to a few millimeters.

Penetration is the passage of some material through a filter or other collector.

Performance Audit is a quantitative check of an analytical procedure with a material or device with known properties or characteristics to verify the accuracy of a project measurement system. The audit is usually performed by a person different from the routine operator/analyst, using standards and equipment different from the calibration equipment.

Plate Out is a thermal, electrical, chemical, or mechanical action that results in a loss of material by deposition on surfaces.

Point Source is the single defined point (origin) of an airborne release such as a stack or vent.

Precision is the dispersion around a central value, usually represented as a variance, standard deviation, standard error, or confidence interval.

Proficiency Testing is a special series of planned tests to determine the ability of field technicians or laboratory analysts who normally perform routine analyses. The results may be used for comparison against established criteria, or for relative comparison with the results from another group of technicians or analysts.

Proportional Sample is a sample consisting of a known fraction of the original stream.

Quality refers to the totality of features and characteristics of a material, process, product, service, or activity that bears on its ability to satisfy a given purpose.

Quality Assurance (QA) refers to those planned and systematic actions necessary to provide adequate confidence that a facility, structure, system, or component will perform satisfactorily and safely in service. Quality assurance includes quality control (QC), which comprises all those actions necessary to control and verify the features and characteristics of a material, process, product, or service to specified requirements.

Quality Control (QC) refers to those actions necessary to control and verify the features and characteristics of a material, process, product, service, or activity to specified requirements. The aim of quality control is to provide quality that is satisfactory, adequate, dependable, and economic.

Quality Factor (Q) is the principal modifying factor used to calculate the dose equivalent from the absorbed dose. For purposes of DOE 5400.5, the following quality factors are to be used:

<u>Radiation Type</u>	<u>Quality Factor</u>
X-rays, gamma rays, positrons, beta particles, electrons (including tritium)	1
Neutrons, <10 keV	3
Neutrons, >10 keV Protons and single-charged particles of unknown energy with rest mass greater than one atomic mass unit	10
Alpha particles and other multiple-charged particles (other heavy ions and particles of unknown charge) of unknown energy	20
For neutrons of known energies, the more detailed quality factors given in DOE 5480.11 may be used.	

Radioactive Material refers to any material or combination of materials that spontaneously emits ionizing radiation.

Radionuclide refers to a radioactive nuclide. There are several hundred known radionuclides, both produced and naturally occurring; radionuclides are characterized by the number of neutrons and protons in an atom's nucleus.

Radionuclide Emissions are releases of radioactive materials to the environment.

Random Error refers to variations of repeated measurements made within a sample set that are random in nature and individually not predictable. The causes of random error are assumed to be indeterminate or nonassignable. Random errors are generally assumed to be normally distributed.

Random Samples are samples obtained in such a manner that all items or members of the lot, or population, have an equal chance of being selected in the sample.

Range is the difference between the maximum and minimum values of a set of values.

Readout is the device that conveys information regarding the measurement being made to the user.

Reference Source - See "Check Source."

Reference Man refers to a hypothetical aggregation of human (male and female) physical and physiological characteristics arrived at by international consensus (ICRP Publication 23). These characteristics may be used by researchers and public health workers to standardize results of experiments and to relate biological insult from ionizing radiation to a common base. "Reference man" is assumed to inhale 8400 m³ of air in a year and to ingest 730 L of water in a year.

Relative Error is an error expressed as a percentage of the true value or accepted reference value.

Reliability is the capability of a system to perform a required function under stated conditions for a stated period of time.

Repeatability is the precision, usually expressed as a standard deviation, measuring the variability among replicates. It refers to the closeness with which the measurements agree with each other.

Replicability is the precision, usually expressed as a standard deviation, measuring the variability among replicates.

Replicates are repeated but independent determinations of the same sample.

Representative Sample is a sample taken to depict the characteristics of a lot or population as accurately and precisely as possible. A representative sample may be a "random sample" or a "stratified sample" depending upon the objective of the sampling and the characteristics of the conceptual population.

Reproducibility is the degree of precision of a laboratory (repeatedly) and/or of different laboratories obtaining the same measurement values of the same sample.

Response Time is the time interval between when the detector senses a charged particle (e.g., β , α) or photon (e.g., γ , x-ray) and when the signal is registered by the measurement system's data storage device.

Ruggedness Testing is a special series of tests performed to determine the sensitivity of a measurement system to variations of certain factors suspected of affecting the measurement system.

Sample has two definitions: 1) A subset or group of objects selected from a larger set, called the "lot" or "population"; and 2) an extracted portion or subset of an effluent stream or environmental media.

Sample Blank - See "Blank."

Sampling is the extraction of a prescribed portion of an effluent stream or of an environmental medium for purposes of inspection and/or analysis.

Sensitivity is the minimum amount of a radionuclide or other material of interest, expressed as a ratio (e.g., % or ppm), that can repeatedly be detected by an instrument, system, or procedure.

Sequential Sampling refers to timed samples collected from an effluent stream.

"Should" Statements indicate performance criteria and procedures required to operate and maintain an acceptable radiation protection program for the public and the environment.

"Should" Statements indicate flexible guidance for an acceptable radiation protection program.

Site refers to the overall DOE complex consisting of one or more facilities located in a defined geographic area.

Source (Radioactive) is either 1) a known amount of radioactive material emanating a characteristic amount of energy in the form of alpha, beta, gamma, neutron, or x-ray emissions (or a combination of such emissions), or 2) a single process or release point that contributes to or causes a release to the environment and that can be separated from other processes by a break in the flow of material.

Spiked Sample is a normal sample of material (gas, liquid, or solid) to which a known amount of some substance of interest is added. Spiked samples are used to check on the accuracy of a routine analysis or the recovery efficiency of an analytical method.

Standard is a material having a known property that can be accurately established based on its physical or chemical characteristics.

Standard Deviation is an indication of the dispersion of a set of results around the average of samples collected or the mean of a population; it is the positive square root of the sample variance. For samples taken from a population, the standard deviation, s , is calculated as:

$$s = \left[\frac{\sum_{i=1}^n (X_i - \bar{X})^2}{n - 1} \right]^{1/2}$$

where \bar{X} = average value of the samples measured
 n = number of samples measured
 X_i = individual measurement value for sample i .

For a finite population, the standard deviation (σ) is

$$\sigma = \left[\frac{\sum_{i=1}^N (X_i - \mu)^2}{N} \right]^{1/2}$$

where μ is the mean value of the population and N is the number of values within the population.

Standard Operating Procedures (SOP) refers to a written document that details an operation, analysis, or action whose mechanisms are thoroughly prescribed and are commonly accepted as the method for performing certain routine or repetitive tasks.

Standard Reference Material (SRM) is a material produced in quantity, of which certain properties have been certified by the National Institute of Standards and Technology (NIST) to the extent possible to satisfy its intended use. The material should be in a matrix similar to actual samples to be measured by a measurement system or to be used directly in preparing such a matrix. Intended uses include standardization of solutions, calibration of equipment, and auditing the accuracy and precision of measurement systems.

Standard Reference Sample (SRS) is a carefully prepared material produced from or compared against a Standard Reference Material (SRM) such that accuracy is maintained. These samples are intended for use primarily as reference standards to determine the precision and accuracy of measurement systems, to evaluate calibration standards, and to evaluate quality control reference samples.

Standardization is a physical or mathematical adjustment or correction of a measurement system to make the measurements conform to predetermined values.

Standards in Naturally Occurring Matrix are standards that relate to the composition of the sample being measured. Standards in a naturally occurring matrix include standard reference materials and standard reference samples.

Stratified Sample (Stratified Random Sample) refers to a sample consisting of various portions that have been obtained from identified subparts or subcategories (strata) of the total lot or population. Within each category or stratum, the samples are taken randomly. The objective of taking stratified samples is to obtain a more representative sample than might be obtained by a completely random sampling.

Systematic Error is the condition in which there is a consistent deviation of the results from the actual or true values by a measurement process. The cause for the deviation, or bias, may be known or unknown; however, it is considered "assignable" (i.e., the cause can be reasonably determined).

Testing is short-term evaluation of radioactive material releases that is representative of typical operations using prescribed techniques.

Tolerance Limits refers to a particular type of confidence limit used frequently in quality control work, where the limits apply to a percentage of the individual values of the population.

Traceability refers to a documented chain of comparisons connecting a working standard (in as few steps as is practical) to a national (or international) standard, such as a standard maintained by the NIST.

Unusual Occurrence is any sudden release or sustained deviation from a regulated or planned performance at a DOE operation that has environmental protection and compliance significance.

Upset - See "Abnormal Operation."

Variability is a general term for the dispersion of values in a data set.

Variance is a measure of the variability of samples within a subset or the entire population. Mathematically, the sample variance (s^2) is the sum of squares of the differences between the individual values of a set and the arithmetic average of the set, divided by one less than the number of values:

$$s^2 = \frac{\sum_{i=1}^n (X_i - \bar{x})^2}{n - 1}$$

where X_i = value of sample i
 \bar{x} = average of samples measured
 n = number of samples measured.

For a finite population, the variance (σ^2) is the sum of squares of deviations from the arithmetic mean, divided by the number of values in the population:

$$\sigma^2 = \frac{\sum_{i=1}^N (X_i - \mu)^2}{N}$$

where μ is the mean value of the population and N is the number of values within the population.

Weighting Factors (W_T) are tissue-specific and represent the fraction of the total health risk resulting from uniform, whole-body irradiation that could be contributed to that particular tissue. They are used in the calculation of annual and committed effective dose equivalent to equate the risk arising from the irradiation of tissue T to the total risk when the whole body is uniformly irradiated. The weighting factors recommended by the ICRP (Publication 26) and used here are

<u>Organ or Tissue</u>	<u>Weighting Factor</u>
Gonads	0.25
Breasts	0.15
Red Bone Marrow	0.12
Lungs	0.12
Thyroid	0.03
Bone Surfaces	0.03
Remainder ^(a)	0.30

- (a) Remainder means the five other organs with the next highest risk, including liver, kidney, spleen, thymus, adrenals, pancreas, stomach, small intestine or upper and lower large intestine, but excluding skin, lens of the eye, and extremities. The weighting factor for each such organ is 0.06.

Whole-Body refers, for radiation dose purposes, to the uniform exposure of all organs and tissues in a human body.

Working Standard (Quality Control Reference Sample) is a material used to assess the performance of a measurement system. It is intended primarily for routine intralaboratory use in maintaining control of accuracy and should be prepared from or traceable to a calibration standard.